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April 14, 1987

ILLINOIS EPA COMMENTS ON

THE MONSANTO W. G. KRUMMRICH

PLANT AND SAUGET TREATMENT

PLANT SITES

Illinois Environmental Protection Agency

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Project Manager

I. INTRODUCTION

Geraghty & Miller, Inc. have prepared two assessments of groundwater conditions at the Monsanto Company W. G. Krummrich Plant and at the Village of Sauget Treatment Plant Site. The assessment of the W.G. Krummrich Plant groundwater conditions is dated September 1986 and the assessment of conditions at the Sauget Treatment Plant Site is dated December 1986. In addition, Geraghty & Miller has prepared a document outlining the proposed remedial action at the Monsanto Krummrich Drum Site. Personnel from the Illinois Environmental Protection Agency and a consultant from Harza Environmental Services, Inc. have reviewed the results and recommendations based on knowledge of the site conditions, state laws and the goals for environmental protection in Illinois.

The personnel performing this review represent many different technical disciplines and areas of responsibility. These comments have been condensed into the next section of this report. The original comments are included as appendices and referenced in the following sections. Comments that are not referenced or any part of a comment not contained in any appendix can be assumed to be that of the author.

The general conclusions of this joint review can be summarized by stating that the assessment needs to be expanded. Downgradient and deep aquifer conditions are not adequately described. Both onsite and offsite sources of contamination have not been sufficiently identified. The severe groundwater contamination is an areawide problem. The study must be comprehensive in scope. The recommendations for remedial action are far too narrow. Many good possibilities for remedial action were unnecessarily discarded or not considered at all. Known contamination problems representing substantial risks to the public health and environment are dismissed. Comments contained in the following section support the aforementioned conclusions.

II. ILLINOIS EPA COMMENTS ON THE GERAGHTY & MILLER ASSESSMENT OF AND RECOMMENDATIONS FOR THE GROUNDWATER CONTAMINATION NEAR MONSANTO IN SAUGET.

A. Extent of Contamination

1. The claim that contaminants have not moved more than 300 feet downgradient in the groundwater from the Krummrich Drum Site is neither proved by the evidence in the report nor accepted by this Agency. Geraghty & Miller presented little information on groundwater conditions downgradient (west) of the drum disposal site, particularly around the distance of 300 feet. Monitoring results from the nearest downgradient well, B-29, demonstrate a mean concentration of pollutants 2500 feet downgradient from the drum site of 1,393,000 ug/l in the shallow zone and 359,000 ug/l in the intermediate zone. Monitoring detected large amounts of nitrochlorobenzenes in well B-29 and two nearby wells, B-24 and B-25. Monsanto disposed of large amounts of various nitrochlorobenzenes in the drum site. It has not been demonstrated that these contaminants did not originate in Monsanto's past disposal practices near the Krummrich Drum Site. (See Appendix C.)

the proposed remedial action is to further decrease the loading of the groundwater by the constituents in the lagoons and pit. "Remedial action with respect to groundwater contamination itself appears to be unnecessary."

In light that the study has not fully determined the extent or characterization of the pollutants in the lagoons or pit, the report's conclusion and recommendation are premature. Semantics aside, the consultant has not shown "respect" for either the groundwater or the potential harm of the contaminants. The current declining use of the aquifer due to ever-decreasing quality is not an acceptable condition. Contamination by others does not preclude or absolve the Sauget Treatment Facilities from adding to the contaminant loading. And decreasing contaminant loading under current site conditions is not a permanent solution.

The report's recommended remedial action for the lagoons and pit is the construction of slurry walls and a clay cap. The recommended slurry walls raises concern of the consultants confidence in his own analysis. What possible force could initiate a lateral flow of a somewhat plastic material through a silty sandy medium? Whatever force is contemplated, wouldn't downward flow through the same medium be of greater concern? If concern of lateral movement is great enough to recommend a hundred thousand square foot slurry wall, shouldn't the lagoon and pit floor require some sort of remedial action?

Assuming a clay cap and sidewalls are constructed in an effective manner, two situations could seriously defeat their remedial intent. The first is change of land use at the surface and the second is an unexpected rise in groundwater elevation. The clay cap will require monitoring and maintenance indefinitely, and changes in the groundwater level may not be as static as the consultant believes.

As an additional feature to a leave in-place alternative, it may be possible to inject a chemical grout beneath the lagoons. Injected under a high enough pressure so that the in-situ soil would be displaced, the grout may be accepted into the soil matrix. The more permeable zones which form the conduits of the contamination plumes would be the most susceptible for grout acceptance. Normally grout injection into a silty sand isn't economically feasible, but when compared to excavation, destruction and backfill, a grout formed bottom seal may be an attractive possibility. A broader list of remedial alternatives may uncover a more permanent solution to the proposed cap and sidewalls.

RLJ:cas/0052L

cc: DLPC - Collinsville
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APPENDIX C

TOM HORNSHAW AND CONNIE SULLINGER

ON THE KRUMMRICH DRUM SITE

Identification of Chlorinated Nitrobenzene Residues in Mississippi River Fish

MARTIN E. YURAWECZ and BART J. PUMA
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Residues of lower chlorinated nitrobenzenes have been found at levels up to about 1 ppm in 8 samples of Mississippi River fish. Electron capture gas chromatography (EC/GC) was used for determination after extraction and cleanup using a procedure based on the AOAC multiresidue method for organochlorine and organophosphorus pesticides in nonfatty foods. The residues found included 2-, 3-, and 4-chloronitrobenzene and 2,3- and 3,4-dichloronitrobenzene; identity was confirmed by GC/mass spectrometry. GC retention times for 15 monochloro- through pentachloro-substituted nitrobenzene congeners were determined with OV-101 and mixed OV-101 + OV-210 columns at 130°C. In studies of the nonfatty food extraction and cleanup procedures of the AOAC method, recoveries of 15 chlorinated nitrobenzenes from spiked fish samples ranged from 68 to 116%. GC of cleaned up fish extract aliquots equivalent to 20 mg sample allowed quantitation of individual congeners at levels of about 0.025 and 0.005 ppm with ^{3}H and ^{63}Ni EC detectors, respectively. The contamination of Mississippi River fish with chlorinated nitrobenzenes appears to be localized in a 150 mile section of the river extending from St. Louis, MO, to Cape Girardeau, MO; no chlorinated nitrobenzenes (<0.005 ppm) were detected in Mississippi River fish caught above or below this region of the river or in fish from the lower Missouri River, which joins the Mississippi River near St. Louis.

Food and Drug Administration (FDA) personnel use the AOAC official multiresidue method for organochlorine and organophosphorus pesticides (secs. 29.001-29.018 (1)) to analyze foods for many potentially hazardous contaminants besides those for which the method has official status (2). Since 1976, FDA monitoring programs for pesticide and industrial chemical residues in foods have included analyses of selected food samples, mainly of domestic freshwater fish, for residues of electron-capturing industrial chemicals that are recovered in the 6% ethyl ether–petroleum ether eluate of the Florisil cleanup procedure (sec. 29.015 (1)), but are too volatile for electron capture gas chromatography (EC/GC) analysis at the operating conditions recommended in sec. 29.018 (1). EC/GC of these volatile compounds, called "early eluting industrial chemicals" because they elute from the OV-101 GC column before the residues usually determined by the method, is carried out with the OV-101 column temperature at 130°C instead of the recommended 200°C for pesticides. As part of an ongoing FDA program to identify new or previously unrecognized industrial chemical contaminants of foods, our laboratory investigates food samples that give unidentified analytical responses when monitored for early eluting industrial chemicals at FDA field laboratories.

In one of these investigations, monochloro- and dichloronitrobenzene residues were identified in a sample of Mississippi River buffalofish caught about 60 miles south of St. Louis, MO. The sample was first noted to yield an unidentified EC/GC response in an analysis for early eluting residues at the FDA Minneapolis District laboratory. When the analytical characteristics of the unknown compound were found to differ from those of the compounds listed in an FDA compilation of GC characteristics and AOAC method behavior data for volatile industrial chemicals, the sample was sent to this laboratory for further study. After the residues were tentatively identified as monochloro- and dichloronitrobenzene congeners by GC/mass spectrometry (MS), retention times and recoveries through the nonfatty food extraction and cleanup procedures of the AOAC method (1) were determined for 15 monochloro- through pentachloronitrobenzene congeners. Follow-up analyses of 12 additional fish samples from the Mississippi River and 6 fish samples from the last 300 miles of the Missouri River were performed. Chloronitrobenzenes were found at levels up to about 1 ppm in 7 samples caught in the Mississippi River near or below St. Louis. Residues found included 2-, 3-, and 4-chloronitrobenzene and 2,3- and 3,4-dichloronitrobenzene; their identities were confirmed by GC/MS comparisons with reference standards of the congeners.

Monochloronitrobenzenes have been reported as contaminants of river and drinking waters (3), but neither these compounds nor dichloronitrobenzenes have previously been reported as environmental contaminants of fish or other foods. Annual United States production of

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monochloronitrobenzenes, chiefly the 2-chloro and 4-chloro isomers, is about 150 million lb; these toxic chemicals serve mainly as starting materials for the production of nitrophenols, nitroanilines, chloroanilines, and other intermediates used to manufacture dyes, pigments, pesticides, rubber chemicals, corrosion inhibitors, and pharmaceuticals (4). Pentachloronitrobenzene (quintozene) and 2,3,5,6-tetrachloronitrobenzene (tecnazene) are registered for use as pesticides in the United States; both occur as residues in foods (5).

The method used for determining the chlorinated nitrobenzene residues in fish is based on the AOAC official method for organochlorine pesticide residues in high-moisture nonfatty foods (1). Residues are extracted from the ground sample with acetonitrile, transferred to petroleum ether, cleaned up by Florisil column chromatography, and analyzed by GC. The procedure differs from the AOAC method as follows: The sample size is reduced so that the total weight does not exceed 50 g and the total fat content does not exceed 2 g; interfering residues such as hexachlorobutadiene (HCBD) are removed from the Florisil column by elution with 100 mL petroleum ether before the usual 200 mL 6 and 15% ethyl ether–petroleum ether eluates are collected; and EC/GC is performed at a column temperature of 130°C. Similar modifications have been used to analyze fish for residues of HCBD, chlorinated norbornene derivatives, and chlorinated benzotrifluorides (6–8).

Experimental

Reagents

(a) *General reagents.*—See sec. 29.002 (1). Solvents and reagents were tested for interferences using the GC parameters described below.

(b) *Reference materials.*—2-Chloronitrobenzene (No. 18,576-0), 4-chloronitrobenzene (No. C5,912-2), 2,3-dichloronitrobenzene (No. D6,820-7), 3,4-dichloronitrobenzene (No. D6,880-0), 2,4-dichloronitrobenzene (No. D6,840-1), 2,3,4-trichloronitrobenzene (No. T5,518-8), 2,4,5-trichloronitrobenzene (No. T5,520-4), 2,3,4,5-tetrachloronitrobenzene (No. T770-5), and pentachlorobenzene (QCB) (No. 13,132-6) were purchased from Aldrich Chemical Co., 940 W St Paul Ave, Milwaukee, WI 53233. 3-Chloronitrobenzene (No. P1100) and 2,4,6-trichloronitrobenzene (No. 7594) were purchased from Eastman Kodak Co., 343 State St, Rochester, NY 14650. 3,5-Dichloronitrobenzene (No. D16190) was obtained from Pfaltz & Bauer, Inc., 375 Fairfield Ave, Stamford, CT 06902. 2,3,5,6-Tetrachloronitrobenzene (EPA/FDA No. 144) and pentachloronitrobenzene (EPA/FDA No. 111) were supplied by the Environmental Protection Agency, Health Effects Research Laboratory, Research Triangle Park, NC 27711. 2,5-Dichloronitrobenzene and 2,6-dichloronitrobenzene were obtained from S. W. Page, Division of Chemistry and Physics, FDA, Washington, DC 20204. Standard solutions of the reference materials were prepared in isooctane. QCB was used as the reference compound for GC relative retention measurements.

Apparatus

(a) *General apparatus.*—See sec. 29.005 (1).

(b) *Gas chromatograph with ^{3}H EC detector.*—As described in sec. 29.008 (1), with the following glass columns: (1) 1.8 × 4 mm id, packed with 10% OV-101 on 80–100 mesh Chromosorb W (HP); (2) 1.8 m × 4 mm id, packed with 10% OV-101 on 80–100 mesh Chromosorb W (HP) and 15% OV-210 on 80–100 mesh Chromosorb W (HP) (1 + 1). Operating conditions: nitrogen carrier gas ca 120 mL/min; temperatures (°C)—column 130, inlet 150, detector 200; recorder span 5 mV; electrometer sensitivity 1×10^{-9} A for full-scale deflection (FSD) of recorder pen. Nitrogen carrier flow was set to elute QCB in 8–10 min from either column; detector voltage was adjusted to produce 1/2 FSD for 1.5 ng QCB.

(c) *Gas chromatograph with ^{63}Ni constant current EC detector.*—Hewlett-Packard 5730A or Varian 3700 with the following columns: (1) 1.8 m × 4 mm id glass, packed with 5% OV-101 on 80–100 mesh Chromosorb W (HP); (2) 1.8 × 4 mm id glass, packed with 5% OV-101 on 80–100 mesh Chromosorb W (HP) and 7.5% OV-210 on 80–100 mesh Chromosorb W (HP) (1 + 1); (3) 25 m × 0.2 mm id OV-101 wall-coated open tubular (WCOT) flexible fused silica capillary. Operating conditions: argon–methane (95 + 5) carrier gas 60 mL/min (columns 1 and 2); nitrogen carrier gas 1 mL/min (column 3) with 20 mL/min split flow and 30 mL/min detector make-up; temperatures (°C)—column 130, inlet 250, detector 300; recorder span 1 mV. Detector attenuation was set to give ca 1/2 FSD for 1.5 ng QCB.

(d) *Combined gas chromatograph-mass spectrometer (electron impact (EI))-data system.*—Varian 1700 gas chromatograph/Finnigan 1015 quadrupole mass spectrometer/Finnigan 6000 data system. The gas chromatograph was coupled to the mass spectrometer through a Gohlke all-glass separator and vacuum diverter valve installed in

the GC detector oven between the column and separator (9). Glass GC column: 1.8 m × 2 mm id. packed with 3% OV-101 on 80–100 mesh Chromosorb W (HP). Operating conditions: helium carrier gas 20 mL/min; temperatures (°C)—column 130, inlet 150, separator 260, transfer line 220, ion source 150; mass spectrometer pressure 2×10^{-5} torr; filament emission 500 μA; preamplifier 10^{-7} A/V; 70 eV primary ionizing voltage in EI mode; scanned mass range m/z 33–350; integration time 6 ms/atomic mass unit; data acquisition under computer control.

(e) *Combined gas chromatograph-mass spectrometer (chemical ionization (CI))-data system.*—Finnigan 9600 gas chromatograph/Finnigan 4023T quadrupole mass spectrometer equipped with pulsed positive ion negative ion (NI) CI option/INCOS 2300 data system. The gas chromatograph was directly coupled to the mass spectrometer ion source through a 25 m × 0.2 mm id OV-101 WCOT flexible fused silica capillary column. Splitless injections were made at the following operating conditions: temperatures (°C)—injector 160, column held at 90° for 1 min after injection, then programmed at 15°/min to 150° and held at 150° for 10 min, separator region 160°, transfer line region 115, ion source 250; helium carrier gas head pressure 10 psi; septum sweep (0.8 min after injection) 40 mL/min; methane reagent gas used to increase source pressure to 0.3 torr; electron energy 70 eV; filament emission 0.25 mA. Samples and reference materials were compared in the NI CI mode using multiple ion detection for ions of m/z 35, 37, 127, 129, 157, 159, 161, 163, 191, 193, and 195 with repetitive 1.2 s scans.

Preparation, Extraction, and Cleanup of Fish

Fish were prepared for analysis in accordance with the edible portion guide of the FDA *Pesticide Analytical Manual* (PAM I) (sec. 141.12c (10)). Before extraction, the edible portion of each sample was thoroughly mixed and ground in a meat grinder as described in *PAM I* (sec. 142.4(5) (10)). Ground fillets of ocean perch were used as the sample substrate in recovery studies. For several fish samples, including ocean perch, the approximate fat content of the edible tissue was determined as in the official fatty food extraction procedure for fish (sec. 29.012(e) (1)).

Residues were extracted from the homogenized fish samples with acetonitrile by using an adaptation of the official extraction procedure for high-moisture nonfatty foods containing <5% sugar (sec. 29.011(a)(1) (1)). This procedure, which is normally applied to extract 100 g samples of fruits or vegetables, was modified for application to fish of known fat content as described in *PAM I* (sec. 211.13(f)(2) (10)), i.e., by reducing the sample weight so that the total amount of fat was ≤2 g (maximum sample size 50 g). For fish of undetermined fat content, the sample weight used in the nonfatty food extraction procedure was limited to 10–15 g, except for one sample, a carp and sucker fish composite, of which two 20–22 g portions were extracted to obtain enough of the residues for GC/MS analysis.

After the residues were extracted from the fish with acetonitrile, they were transferred to petroleum ether (sec. 29.011(e) (1)), and cleaned up by Florisil column chromatography. The Florisil cleanup procedure (sec. 29.015 (1)) was used without modification for most of the recovery studies with fortified samples of ocean perch; for other analyses of fish, the procedure was modified to elute potential interfering residues from the Florisil column with 100 mL petroleum ether before the usual 6, 15, and 50% ethyl ether–petroleum ether eluates were collected. Each of the eluates was evaporated to ca 5 mL in a Kuderna-Danish concentrator equipped with a Snyder distilling column. For EC/GC analysis, the volume of each concentrated Florisil eluate was adjusted with petroleum ether so that a 3–8 μL aliquot was equivalent to 20 mg sample. When further concentration of the eluate was required, as for GC/MS analysis, the solvent was evaporated to a suitable volume in a Kuderna-Danish receiver tube equipped with a micro-Snyder column. (Because of the volatile nature of the residues of interest, solvent evaporation under jets of air or nitrogen was avoided.) The 15% ethyl ether–petroleum ether eluates were stored in the dark unless their EC/GC analyses were completed on the same day as the Florisil column cleanup. When these eluates or their concentrates were allowed to stand in normal laboratory light, the "solvent" peaks in their EC chromatograms increased in size as a function of time and became large enough in ca 1 week to obscure the responses for monochloronitrobenzenes.

Gas Chromatography

A 10 μL syringe was used to inject 3–8 μL aliquots of the concentrated sample eluates and reference standard solutions for analysis by EC/GC. Retention times of peaks for residues and standards were measured from the solvent peak front and converted to retention times relative to QCB. Peak height was used as the mea-

5. The study shows a second deep cone of depression just to the west of the Monsanto cone of depression (Figure 5). Geraghty & Miller do not discuss the influence of this cone of depression on contaminant migration. If this pumping continued for even a short time after pumping at the Monsanto plant ceased, then pollutants could have been pulled strongly to the west. There is once again a lack of history.

6. The pollutant plume area affected by the drum site cannot be defined by completed borings or existing wells. The only valid information available is that the drum disposal trench, the soil in the immediate vicinity and the shallow aquifer are highly contaminated. The intermediate and deep zones under the drum disposal area contain contaminated groundwater (GM-31). The study presents little further information on which to base conclusions. (See Appendix A.).

7. The Geraghty & Miller report on groundwater contamination at the Sauget Treatment Plant Sites concludes that contaminants found in the shallow zone are unlikely to have reached the river. The report also suggests that the volatile contamination found in shallow well GM-22A could be from an offsite source. The distance from the river to GM-22A is not much more than the distance from GM-22A to the nearest upgradient (east) boundary. The distance from GM-22A to the nearest known upgradient source is over 2000 feet. The conclusions that contaminants from the site have not had time to migrate in the shallow zone to the river but have had time to migrate to GM-22A from offsite seem contradictory. The information on the sources of contamination and/or groundwater velocity are incomplete and do not support the Geraghty & Miller conclusions (See Appendix B.)

8. One explanation for the groundwater monitoring results at the treatment plant site would be that contaminants are migrating from the lagoons and pit in discreet plumes (or "fingers") rather than one homogeneous plume. This explanation could account for the range of concentrations and constituents identified downgradient. The wells installed onsite could be in different "fingers or missing them altogether. (See Appendix B.)

9. Volatile organic compounds identified at the Sauget Treatment Plant in well clusters GM-19, GM-20 and GM-21 increase with depth. Because no downward gradient was detected in the vicinity and because concentrations in these three wells increase with depth, Geraghty & Miller conclude that the volatiles migrated from offsite. Concluding that the volatile organics have migrated horizontally to their present locations is easily supported but in the absence of a known offsite source, it is difficult to blame an offsite source. GM-22A had the highest level of volatile organic compounds of all wells and is much closer than any offsite source. Other places onsite may just as easily be the source of volatile organics as an offsite source. Onsite sources of contamination have not been adequately addressed by the study. (See Appendix B and Appendix H.)

6. Groundwater contaminants at the W.G. Krummrich Plant were once captured in cones of depression and removed by pumping. A similar system could be implemented as a groundwater remediation measure. The plant uses and no doubt treats river water. Substituting the pumping and treating of contaminated groundwater for use in the plant would be a remedial measure with two virtues. The first would be that substituting treatment of groundwater for the treatment of river water would help offset the costs. Because the plant uses large amounts of water, and will hopefully be in production for many years, the requirement that large quantities of groundwater be removed and treated will be met. The second virtue is the inherit fairness of Monsanto returning to use the groundwater resource that they abandoned due to their own pollution and thereby helping restore its original quality.

D. OTHER TECHNICAL ISSUES

1. What is the source of the black silt, sand, gravel and cinders identified on many of the boring descriptions (Vol III. Appendix B)? Was any of this material sampled individually? If so, what are the results? (See Appendix H.)

2. In Volume III page A-4 does not follow A-3 coherently. (See Appendix H.)

3. Volume III, Appendix A states that bentonite slurry was used to seal the annullus directly above the screened interval. However, many of the well construction logs in Appendix C state that pellets were used. How were the pellets hydrated and for how long? (See Appendix H.)

4. Many standards and objectives for chemical contaminants are exceeded by the groundwater contamination at the Krummrich Plant and Sauget Treatment Plant. These contaminants have various human and environmental toxicities. The Mississippi River is the ultimate receiver of many of these chemicals. (See Appendix D.)

E. REGULATORY ISSUES

1. For facilities, like Monsanto, seeking a RCRA permit, simply capping and monitoring solid waste management units will not be adequate to meet the 3004 (u) and 3008 (h) provisions of RCRA as they relate to continuing releases from those solid waste management units. (See Appendix I.)

2. The Geraghty & Miller proposals will not eliminate releases to groundwater and subsequent disposal into the environment. Groundwater is a state resource, not Monsanto's resource to contaminate as they find it economically convenient. (See Appendix G.)

3. In a letter to Monsanto dated December 18, 1986, the Illinois EPA declared the proposal to cap the Krummrich Drum Site to be

III. APPENDICES

A. R.L. Johnson on the Krummrich Drum Site.

B. R.L. Johnson on the Sauget Treatment Plant Site.

C. Tom Hornshaw and Connie Sullinger on the Krummrich Drum Site.

D. Connie Sullinger and Tom Hornshaw on the Sauget Treatment Plant Site.

E. Tom Hornshaw and Connie Sullinger on the Sauget Treatment Plant Site.

F. William C. Child letter to Monsanto.

G. Geordie Smith on the Krummrich Plant Site.

H. Rob Watson on the Krummrich Plant Site.

I. Rob Watson on the Sauget Treatment Plant Site.

J. Angela Tin on Sauget Treatment Plant and Krummrich Plant Sites.

APPENDIX A

R. L. JOHNSON ON THE KRUMMRICH DRUM SITE

CONFIDENTIAL

MEMORANDUM

DATE: December 5, 1986

TO: Ken Mensing

FROM: R.L. Johnson - HES Oversight - Southern Region

SUBJECT: 1631210006 - St. Clair Co. - Sauget/Monsanto-Krummrich Drum Site Superfund - Technical

In reference to Geraghty & Miller's groundwater study of conditions at Monsanto's Krummrich Plant in Sauget; the stated conclusion of the study is that although plant operations have affected groundwater quality, offsite impact is minimal because the aquifer dilutes the contamination to acceptable levels. This conclusion is both short-sighted and incorrect based on the following observations.

In examining Figures 26 & 27 it is apparent that the contamination plume increases in areal size with depth. The decrease in concentration with depth is caused primarily by the increase of aquifer flow in the deeper zone rather than a decrease in loading. (Note that the predicted flow velocity of the deep aquifer zone is on the order of 300 times the velocity of the shallow zone.) Had a plan of the area where organic compounds exist in the deep zone been prepared, the plume may very well extend from the plant to the river (see noted concentrations on Fig. 25).

The offsite impact of the contamination plume is not fully addressed in the study, as evidenced by the title of Figures 26 & 27, "Approximate Areas (of) Organic Compound Concentrations...on the Monsanto Property." A cursory look at these figures would lead one to believe the plume ends at the Monsanto property line. However it is obvious of the plume extends south of Monsanto property but is simply not shown.

The report stated that the affect of the contamination plume upon the environment and therefore human exposure is minimal because no water supply wells are in the area. As few as fifteen years ago more than 20 MGD was being pumped from this area, to as little as .5 MGD today. The primary reason for the decrease of pumpage as stated in the report is "regional deterioration in water quality." (Vol. I, Page 7). Groundwater contamination has had profound affect upon the region, both on-site and off-site Monsanto property.

The reversal of groundwater flow direction due to decreased pumping has probably had the effect of increasing contamination concentration. The heavy pumping produced deep cone of depressions near the source of the pollutants. The pollutants were probably pumped out of the aquifer almost as quickly as they entered. Since the end of the heavy pumpage, the pollutants remain in the aquifer with the effect of an ever-increasing plume and concentrations.

APPENDIX B

R. L. JOHNSON ON THE SAUGET TREATMENT PLANT SITE

M E M O R A N D U M

DATE: February 8, 1987

TO: Ken Mansing CONFIDENTIAL

FROM: R. L. Johnson - HES Oversight - Southern Region

SUBJECT: 1630200005 - St. Clair Co. - Dead Creek/Sauget Sites
Superfund - Technical

The Geraghty & Miller groundwater assessment study for the Sauget Treatment Plant sites has been reviewed and comments are contained herein. The report is similar in content and presentation to the G&M report concerning the Monsanto property. Monsanto is referred to indirectly as an offsite property to the east but no information relating to Monsanto is mentioned in this study.

The study consisted of an inventory of wells within a two mile radius of the site (excluding Monsanto wells), the drilling of twelve soil test borings, installation of fourteen monitoring wells at seven locations, determination of hydrogeologic parameters and identifying concentrations of hazardous constituents in the groundwater. Previous studies of the site were referred to but they were not available for cross-checking with the newly acquired information.

The groundwater assessment is based principally on two premises. One, because concentrations particularly organic compounds increase with depth, the primary source of the contaminants are offsite, upgradient, to the east. Two, due to low groundwater velocity it is unlikely that any contaminants from the lagoons and pit have yet reached the river. However, the report's explanation of the highest recorded mean concentrations of pollutants in Well GM-22A refute this analysis. The pollutant load of 4900 ug/l reported in the water table zone of Well-22 is attributed to the old pit as the source but some of the organic compounds are attributed to an offsite source. The maximum reach for the contaminants in the water table zone is calculated as about 150 feet (7.3 feet per year for twenty years of activity at this site). Well GM-22 is 400 feet from the pit and over 2000 feet (equivalent to 275 yrs.) from the nearest upgradient source. Either the sources of the contaminants are incorrect, or the groundwater velocity is incorrect, or both.

A more probable hypothesis is that the contaminants migrate from the lagoons and pit in discreet plumes (or "fingers") rather than the lagoons and pit acting a large point source creating one homogeneous plume. The chances of one of the five shallow downgradient wells intersecting a "finger" would depend upon the geometry of the plume(s). Judging from the range of concentrations and identified constituents, it is probable that the contamination plumes have not been fully located and the contamination in general has not been fully characterized.

The conclusion of the study is that the lagoons and pit have adversely impacted groundwater quality but only to a degree which does not affect current aquifer uses. High concentrations of organic compounds were attributed to "properties to the east". In response to these conclusions

sure of EC response. Amounts of residues in the injected aliquots of samples were determined by comparing residue peaks with standard peaks of similar heights within the linear response range of the EC detector. An OV-101 WCOT capillary column was used to determine the level of 3-chloronitrobenzene in a composite of Mississippi River carp and sucker fish. All other residues were quantitated with mixed OV-101 + OV-210 columns. (The OV-101 packed columns were used only for screening and/or confirmatory purposes.)

Results and Discussion

In the analysis of the buffalofish sample at the FDA Minneapolis District laboratory, the AOAC multiresidue method (1) was modified to elute polychlorinated biphenyls from the Florisil column with petroleum ether before the usual 6% ethyl ether–petroleum ether eluate was collected. EC/GC of the petroleum ether eluate on OV-101 and OV-101 + OV-210 columns at 130°C gave chromatograms with a major peak at the retention time of HCBD on each column. Examination of the 6% mixed ether eluate at the EC/GC conditions revealed an unknown compound that eluted from the OV-101 column at about the retention time of HCBD, but that eluted from the OV-101 + OV-210 column at more than twice the retention time of HCBD. In accordance with FDA monitoring program instructions for findings unidentified early eluting residues in foods, a portion of the homogenized buffalofish sample and related analytical information were sent to our laboratory for further study.

Our analysis of the sample of buffalofish was performed as described under *Experimental*. The EC chromatograms of the petroleum ether and 6% ethyl ether–petroleum ether eluates were very similar to those obtained at the Minneapolis laboratory. GC/EI-MS was used to examine both eluates; the MS data confirmed the identity of the HCBD in the petroleum ether eluate and suggested that the residue in the 6% mixed ether eluate was a monochloronitrobenzene. GC retention times were determined for the 3 monochloronitrobenzene isomers; only the 2-chloro isomer eluted from the OV-101 and mixed OV-101 + OV-210 columns at the same retention times as the residue in the 6% mixed ether eluate. GC/EI-MS comparison with the reference standard verified the identification of the residue as 2-chloronitrobenzene.

After the residue was identified, samples of ocean perch were fortified with 2-chloronitrobenzene and analyzed using the same analytical procedure as was used for the buffalofish sample. The results of this recovery study, in which petroleum ether was used as the first eluting solvent in the Florisil column cleanup, showed that the compound eluted in both the 6 and 15% mixed ether eluates, with the bulk of it in the latter.

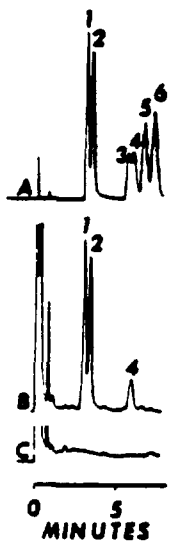

Figure 1. EC (^{63}Ni) gas chromatograms of A, 15% ethyl ether–petroleum ether Florisil eluate of Mississippi River buffalofish (23 mg sample equivalent injected); B, mixture of reference compounds: (1) 1.4 ng 4-chloronitrobenzene, (2) 2.3 ng 2-chloronitrobenzene, (3) 1.0 ng 2,4-dichloronitrobenzene, (4) 1.0 ng 3,4-dichloronitrobenzene, (5) 2.5 ng 2,3-dichloronitrobenzene, and (6) 0.44 ng 2,4,6-trichloronitrobenzene; and C, 15% ethyl ether–petroleum ether eluate of ocean perch (15 mg sample equivalent injected). Mixed OV-101 + OV-210 column with GC conditions in *Apparatus* (c).

Examination of the 15% mixed ether eluate derived from the buffalofish revealed additional 2-chloronitrobenzene and 2 other residues, subsequently identified as 4-chloronitrobenzene and 3,4-dichloronitrobenzene. Although the 15 and 50% mixed ether Florisil eluates of the AOAC method are often examined for early eluting compounds as part of this laboratory's research on volatile contaminants in foods, these Florisil eluates are not examined for early eluting industrial chemicals under present FDA food surveillance programs. Consequently, the 4-chloronitrobenzene and 3,4-dichloronitrobenzene residues in the buffalofish were not detected in the original analysis of the sample.

Figure 1 shows EC/GC curves obtained by using a mixed OV-101 + OV-210 column for analysis of the 15% mixed ether eluate of the

Table 1. Relative retention times[a] of chlorinated nitrobenzenes on packed GC columns[b]

Chlorinated nitrobenzene	OV-101	OV-101 + OV-210
3-Chloro	0.23	0.41
4-Chloro	0.25	0.43
2-Chloro	0.25	0.48
3,5-Dichloro	0.37	0.56
2,6-Dichloro	0.40	0.71
2,5-Dichloro	0.42	0.70
2,4-Dichloro	0.45	0.79
3,4-Dichloro	0.50	0.83
2,3-Dichloro	0.51	0.94
2,4,6-Trichloro	0.64	1.00
2,4,5-Trichloro	0.85	1.33
2,3,4-Trichloro	1.03	1.70
2,3,5,6-Tetrachloro	1.37	1.92
2,3,4,5-Tetrachloro	1.80	2.57
Pentachloro	2.97	3.83

[a] Relative to QCB.
[b] Columns: 5% OV-101; 5% OV-101 + 7.5% OV-210 (1 + 1). GC parameters given in *Apparatus* (c).

buffalofish, a mixture of chlorinated nitrobenzene standards, and the 15% mixed ether eluate of a control sample of ocean perch. The residues indicated by peaks 1 and 2 in the chromatogram of the buffalofish (Figure 1A) eluted from the mixed OV-101 + OV-210 column at the same retention times as 4-chloronitrobenzene and 2-chloronitrobenzene, respectively. When these residues and the corresponding standards (peaks 1 and 2, Figure 1B) were chromatographed on OV-101 columns at 130°C, all eluted at the same retention time. GC/EI-MS comparison of the co-eluting residues with the individual monochloronitrobenzene standards, in combination with the EC/GC retention data, demonstrated that the 15% mixed ether eluate of the buffalofish contained both the 2- and 4-chloronitrobenzene isomers.

The EI mass spectrum of the residue that produced peak 4 in Figure 1A was tentatively identified as that of one or more dichloronitrobenzene isomers. To determine the identity of the specific dichloro isomer(s) and to determine whether other chlorinated nitrobenzenes were present in the sample, the GC characteristics of 15 chloronitrobenzene congeners and the behavior of these compounds in the AOAC nonfatty food extraction and cleanup procedures were investigated.

Table 1 lists the congeners studied and their GC retention times relative to QCB on OV-101 and mixed OV-101 + OV-210 columns at 130°C. (The reported relative retention data are for the columns described in *Apparatus* (c); virtually the same values were obtained with the more heavily loaded columns described in *Apparatus* (b).) The EC responses (peak heights) for the chloronitrobenzenes approximated that of an equal amount of QCB; the ^{63}Ni detector provided about 2–3 times greater response for the chlorinated nitrobenzenes relative to QCB than the ^{3}H detector. The GC retention data for 2 columns indicated that the dichloronitrobenzene isomer in the buffalofish (peak 4, Figure 1A) was 3,4-dichloronitrobenzene. GC/EI-MS comparison of the residue with the standard confirmed this finding.

Table 2. Recovery of chlorinated nitrobenzenes from ocean perch by AOAC pesticide multiresidue extraction/cleanup procedures for nonfatty foods[a]

Chlorinated nitrobenzene	Added, ppm	Rec., %	Eluate[b]
2-Chloro	0.50	69, 71	6, 15
	0.050	68, 74	
3-Chloro	0.42	71	15
	0.042	82	
4-Chloro	0.80	80, 80	15
	0.080	79, 83	
2,3-Dichloro	0.25	83, 95	6, 15
	0.025	87, 92	
2,4-Dichloro	0.20	89, 95	6, 15
	0.020	90, 97	
2,5-Dichloro	0.16	104, 116	6
2,6-Dichloro	0.11	88, 101	6
3,4-Dichloro	0.20	86, 90	15
	0.020	87, 92	
3,5-Dichloro	0.11	88, 107	6, 15
2,3,4-Trichloro	0.24	97, 103	6, 15
	0.024	93, 95	
2,4,5-Trichloro	0.45	95, 102	6, 15
	0.045	100, 102	
2,4,6-Trichloro	0.48	101, 102	6
	0.048	103, 103	
2,3,4,5-Tetrachloro	0.36	99, 104	6, 15
	0.036	95, 99	
2,3,5,6-Tetrachloro	0.37	86, 102	6
	0.037	101, 104	
Pentachloro	1.00	84, 102	6
	0.100	100, 103	

[a] Nonfatty food extraction cleanup (secs. 29.011(a)(*1*) and (e) and 29.015 (1)). Extraction modified for fish as in *PAM I* (sec. 211.13(f)(2) (10)).
[b] Florisil eluate containing compound: 6 = ethyl ether–petroleum ether (6 + 94); 15 = ethyl ether–petroleum ether (15 + 85).

In studies on the behavior of the chloronitrobenzenes in the AOAC nonfatty food method, the Florisil cleanup procedure (sec. 29.015 (1)) was used without the modification made for the analysis of the Mississippi River buffalofish, i.e., the usual 6, 15, and 50% mixed ether eluates were *not* preceded by a 100 mL petroleum ether eluate. (The elution with petroleum ether was omitted so that the recovery data would show the eluates in which the compounds would normally be recovered.) Table 2 lists the recoveries of 15

chloronitrobenzenes from fortified samples of ocean perch and the Florisil column eluate(s) in which each compound was recovered. The recovery values for compounds that split between the 6 and 15% mixed ether eluates were calculated by adding the amounts found in both eluates. No chloronitrobenzenes were found in the 50% mixed ether eluates of the spiked samples. The data in Table 2 indicate that the analytical procedure recovers a smaller portion of the monochloronitrobenzenes (68–83%) than of the dichloro through pentachloro congeners (83–116%); this may reflect losses of the relatively more volatile monochloro compounds in the solvent evaporation steps of the procedure. Based on EC/GC analyses of Florisil eluate aliquots equivalent to 20 mg sample, the method provides chloronitrobenzene residue quantitation limits of about 0.005 and 0.025 ppm with ^{63}Ni and ^{3}H EC detectors, respectively.

Further work with the modified Florisil cleanup procedure used in the analysis of the buffalofish sample has shown that elution of the Florisil column with 100 mL petroleum ether does not recover any of the chloronitrobenzenes listed in Table 2, but may affect the relative amounts of the compounds recovered in the succeeding 6 and 15% mixed ether eluates. The particular lot of Florisil and the total amount of fat applied to the Florisil column also may affect the degree to which these compounds split between the 6 and 15% mixed ether eluates; thus the Florisil elution behavior of the chloronitrobenzenes may vary from that presented as a general guide in Table 2.

To determine whether chloronitrobenzenes as well as the 3 previously identified congeners were present at ≥0.005 ppm in the Mississippi River buffalofish, the EC chromatograms of the 4 Florisil eluates of the sample were examined for responses at the retention times listed in Table 1. The chromatograms of the 15% mixed ether eluate suggested the presence of a residue at the retention time of 3-chloronitrobenzene, as indicated by a slender shoulder at the front of peak 1 (4-chloronitrobenzene) in the OV-101 + OV-210 chromatogram (Figure 1A) and by a similar shoulder at the front of the peak for the co-eluting 2- and 4-chloronitrobenzenes in the OV-101 column chromatogram. For comparison with the sample residues, standard solutions containing 1 part of 3-chloronitrobenzene and 1, 5, or 10 parts of 4-chloronitrobenzene were chromatographed on the OV-101 + OV-210 column (*Apparatus* (c)). The responses for 3-chloronitrobenzene in the resulting chromatograms appeared as the first of 2 overlapping peaks (separated by a valley) for the 1 + 1 mixture, as a discrete shoulder at the front of the major peak for the 1 + 5 mixture, and as a slender shoulder at the front of the major peak for the 1 + 10 mixture. Although the latter shoulder was quite narrow, it was more distinct than the shoulder at the retention time of 3-chloronitrobenzene in the chromatogram of the 15% mixed ether eluate of the buffalofish (Figure 1A). Thus, if 3-chloronitrobenzene was present as a residue in the buffalofish, its indicated concentration was less than 10% of that of the 4-chloronitrobenzene residue. No additional EC/GC responses attributable to chlorinated nitrobenzenes other than the monochloro and 3,4-dichloro congeners were detected in the buffalofish chromatograms.

Upon completion of the buffalofish sample analysis, 18 additional samples of fish from the Mississippi and Missouri Rivers were examined for chloronitrobenzene residues (Table 3). All of the residues were found in fish caught in the Mississippi River near St. Louis or in a 150 mile section of the river south of that city. No chloronitrobenzene residues (<0.005 ppm) were detected in 2 samples of Mississippi River fish collected 100 miles north of St. Louis, 3 samples collected 260–400 miles south of St. Louis, or 6 samples of Missouri River fish. The highest chloronitrobenzene residue levels were found in a composite of carp and sucker fish caught near a chemical waste disposal site at Sauget, IL, a city just across the Mississippi River from St. Louis. EC/GC with both packed columns (*Apparatus* (c)) indicated that the chloronitrobenzene residues in this sample could include the 3-chloro and 2,3-dichloro congeners in addition to the 3 compounds previously confirmed as residues in the buffalofish. Because the packed GC columns did not provide adequate resolution for quantitation of 3-chloronitrobenzene in the presence of larger amounts of 4-chloronitrobenzene and because only one of the columns (OV-101 + OV-210) resolved the 2- and 4-chloro isomers or the 2,3- and 3,4-dichloro isomers, capillary column EC/GC was investigated for analysis of the residues.

A 25 m OV-101 WCOT fused silica capillary column provided adequate resolution of all the monochloro- and dichloronitrobenzenes. Figure 2 shows the chromatograms obtained for injections of the concentrated 6% ether eluate of the Sauget fish composite and a mixture of standard solutions containing the 3 monochloro- and 6 dichloronitrobenzenes. The residues were

Table 3. Chlorinated nitrobenzenes (ppm) found in edible portion of fish from Mississippi River

Species	Origin[a]	2-Chloro	3-Chloro	4-Chloro	2,3-Dichloro	3,4-Dichloro
Catfish	[redacted]	0[b]	[b]	0.008	[b]	[b]
Catfish	[redacted]	0	0.064	[c]	0.19	[b]
Catfish	[redacted]	0	0.053	[c]	0.088	[b]
Catfish	[redacted]	0	0.026	[c]	0.20	[b]
Carp/sucker[d]	[redacted]	0	0.24	0.057[e]	0.63	0.024	0.085
Buffalofish	[redacted]	60[f]	0.12	[c]	0.20	[b]	0.03
Catfish	[redacted]	150[g]	0.006	[b]	0.019	[b]	[b]
Catfish	[redacted]	150[g]	0.027	[b]	0.029	[b]	[b]

[a] Fish collection site, in miles south of St. Louis.
[b] Not detected, limit of quantitation <0.005 ppm.
[c] GC resolution for analysis was inadequate to detect or determine 3-chloronitrobenzene in presence of 10-fold larger amounts of 4-chloronitrobenzene. If 3-chloro isomer is present in sample, its concentration is estimated as <10% of that of 4-chloro isomer.
[d] Composite of 2 species.
[e] Residue value determined using WCOT capillary GLC column.
[f] Near Kimswick, MO.
[g] Near Cape Girardeau, MO.

found at the retention times of the 2-chloro-, 3-chloro, 4-chloro-, 2,3-dichloro-, and 3,4-dichloronitrobenzenes. The presence of these 5 congeners in the 6% mixed ether eluate of the Sauget fish sample was confirmed by comparing the ion current chromatograms obtained for the residues

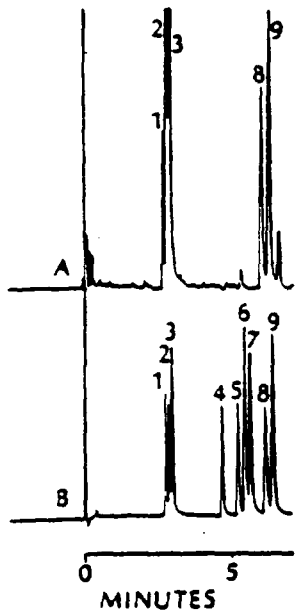

Figure 2. EC (^{63}Ni) gas chromatograms of A, 6% ethyl ether-petroleum ether Florisil eluate of carp/sucker composite (10.5 mg sample equivalent injected); B, mixture of chlorinated nitrobenzene congeners: (1) 3-chloro, (2) 4-chloro, (3) 2-chloro, (4) 3,5-dichloro, (5) 2,6-dichloro, (6) 2,5-dichloro, (7) 2,4-dichloro, (8) 3,4-dichloro, and (9) 2,3-dichloro. OV-101 WCOT capillary column with GC conditions in *Apparatus* (c).

and reference standards by using capillary GC/MS in the NI CI mode with multiple ion detection of ions characteristic of monochloro- and/or dichloronitrobenzenes (*Apparatus* (e)).

EC/GC with the ^{63}Ni detector and the mixed OV-101 + OV-210 column described in *Apparatus* (c) was used to determine the residue levels reported in Table 3, except for 3-chloronitrobenzene, which was determined by using the OV-101 WCOT capillary column. Quantities of compounds found in both the 6 and 15% mixed ether eluates were combined for reporting in Table 3. As shown by Figure 2, the 6% mixed ether eluate of the Sauget fish composite contained 3 compounds which would normally be recovered in the 15% mixed ether eluate, viz., 3-chloro-, 4-chloro-, and 3,4-dichloronitrobenzene. Additional amounts of these compounds (and 2-chloronitrobenzene) were found in the 15% mixed ether eluate; however, this eluate did not contain 2,3-dichloronitrobenzene, a compound which split between the 6 and 15% mixed ether eluates in recovery studies with fortified ocean perch. Although the same lot of Florisil was used as in the recovery studies, the aberrant residue elution pattern was observed for both of the 20–22 g portions of the Sauget fish composite that were processed to obtain enough of the residues for GC/MS analysis. Since the fat content of the composite was not determined, the portions taken for analysis may have contained more than 2 g fat and this, either by itself or in combination with the modification of the Florisil cleanup procedure to use the 100 mL petroleum ether eluate, may have affected the Florisil elution behavior of the residues.

The residue findings reported here indicate

that lower chlorinated nitrobenzenes are contaminants of the 150 mile section of the Mississippi River extending from St. Louis to Cape Girardeau, MO. The examination of fish for these and other of the more volatile chemical contaminants by this laboratory is continuing.

Acknowledgments

The authors thank Douglas W. Phillipson, Division of Chemical Technology (current address Roger Adams Laboratory, University of Illinois, Urbana, IL) and John A. G. Roach, Division of Chemistry and Physics, FDA, for their assistance with the MS analyses. The authors also thank Rodney Bong, FDA Minneapolis District Laboratory; Drew Wilson, Arkansas Game and Fish Commission, Little Rock, AR; and the Missouri Department of Conservation for supplying fish samples.

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APPENDIX D

CONNIE SULLINGER AND TOM HORNSHAW

ON THE SAUGET TREATMENT PLANT SITE

ILLIN ENVIRONMENTAL PROTECTION AGENCY MEMORANDU

DATE: March 17, 1987

TO: Jeff Larson

FROM: Connie Sullinger CS and Tom Hornshaw TH

SUBJECT: Sauget Treatment Plant Sites RI/FS

The attached tables reflect standards and objectives for certain chemicals found in the groundwater at the Sauget Treatment Plant site. These chemicals are singled out because the levels found in the groundwater exceeded a particular standard or objective. The 1/10 96-hr TLm (median tolerance limit) column represents the limit in water necessary for the protection of aquatic life. The consumption of contaminated organisms and water column contains Ambient Water Quality Criteria for water. The numbers represent the allowable limit from a lifetime exposure to a chemical occurring from the consumption of 2 liters of drinking water and 6.5 grams of fish and shellfish per day. The consumption of contaminated organisms values are also Ambient Water Quality Criteria and represent the allowable limit in water to protect human health from a lifetime exposure occurring solely from the consumption of 6.5 grams of aquatic life.

Eight chemicals found in the groundwater at the site did not have readily available data. These chemicals are as follows:

methyl isoamyl ketone
chloroethane
1,2-dichloropropane
methyl isobutyl ketone
2,4-dimethylphenol
2-nitrophenol
4-nitrophenol
4-nitroaniline.

Further data collection, data base searches, QSAR analyses, or requests to USEPA will be needed in order to develop objectives.

CAS/TCH/psf

Sauget Treatment Plant Sites

(all values in µg/l)

Chemical	Groundwater Objective	1/10 96hr TLm (a)	Consumption of contaminated org.[1] & water (b)	Consumption of contaminated org.[1] (b)	Limit for Protection of Public Health (b)	Concentration rang found in groundwater at Sauget
Benzene	5 (c)	2000	6.6 (10^{-5} risk)	400 (10^{-5} risk)		1 - 6980
Chlorobenzene	600 (d)	1600			488	1 - 1100
Methylene Chloride	48 (d)	19300	1.9 (10^{-5} risk)	157 (10^{-5} risk)		2 - 13400
Tetrachloroethylene	6.6 (d)	1300	8.0 (10^{-5} risk)	88.5 (10^{-5} risk)		2 - 290
Trichloroethylene	5 (c)	4100	27 (10^{-5} risk)	807 (10^{-5} risk)		1 - 4840
Vinyl Chloride	1 (c)	2100	20 (10^{-5} risk)	5246 (10^{-5} risk)		6 - 7340
1,1-dichloroethane	5.0 (h)					5.66 - 3560
trans-1,2-dichloroethylene	70 (d)	13500				2 - 19300
Chloroform	100 (e)	1300	1.9 (10^{-5} risk)	157 (10^{-5} risk)		2 - 1100
1,2-dichloroethane	5 (c)	11800	9.4 (10^{-5} risk)	2430 (10^{-5} risk)		< 1 - 233
1,1-dichloroethylene	7.0 (c)	7400	0.33 (10^{-5} risk)	18.5 (10^{-5} risk)		1 - 392
1,1,2,2-tetrachloroethane	1.7 (b)	2000	1.7 (10^{-5} risk)	107 (10^{-5} risk)		< 1 - 551
Toluene	1000 Taste & Odor Threshold	1300	14300	424000		1 - 5460

[1] Organisms

Chemical	Ground-water Objective	1/10 96hr TLm (a)	Consumption of contaminated org.[1] & water (b)	Consumption of contaminated org.[1] (b)	Limit for Protection of Public Health (b)	Concentration rang found in ground-water at Sauget
1,1,1-trichloro-ethane	200 (d)	4000	18400	1030000		5.6 - 2920
1,1,2-trichloro-ethane	6 (b)	4000	6.0 (10^{-5} risk)	418 (10^{-5} risk)		2 - 175
Xylenes	440 (d)	2100				26.2 - 849
Bromoform	100 (e)	2900	1.9 (10^{-5} risk)	157 (10^{-5} risk)		< 1 - 7
Methyl Bromide		1100	1.9 (10^{-5} risk)	157 (10^{-5} risk)		< 1 - 3
Methyl Chloride		55000	1.9 (10^{-5} risk)	157 (10^{-5} risk)		< 1 - 5

[1] Organisms

Sauget Treatment Plant Sites

(all values in µg/l)

Chemical	Groundwater Objective	1/10 96hr TLm (a)	Consumption of contaminated org.[1] & water (b)	Consumption of contaminated org.[1] (b)	Limit for Protection of Public Health (b)	Concentration found in groundwater at Sauget
Pentachlorophenol	220 (d)	2.4			1010	3 - 1430
Phenol	1.0 (f)	1930			3500	2.1 - 1260
2,4,6-trichlorophenol		32	12	36		6 - 24.6
4-chlorophenol		380				3.6 - 1870

[1] Organisms

Sauget Treatment Plant Sites

(all values in µg/l)

Chemical	Ground-water Objective	1/10 96hr TLm (a)	Consumption of contaminated org.[1] & water (b)	Consumption of contaminated org.[1] (b)	Limit for Protection of Public Health (b)	Concentration ran found in ground-water at Sauget
bis-(2-ethylhexyl) phthalate	15 (g)	69	15000	50000		1 - 65
bis-(2-chloroethyl) ether		60000	0.30 (10^{-5} risk)	13.6 (10^{-5} risk)		< 1 - 21.2
1,4-dichloro-benzene	750 (d)	430	400	2600		3.5 - 413

[1] Organisms

Sauget Treatment Plant Sites

(all values in µg/l)

Chemical	Public/Food Processing Std. (f)	Criteria to protect freshwater org.[1] (b)	Consumption of contaminated org.[1] & water (b)	Consumption of contaminated org.[1] (b)	Concentration rang found in ground-water at Sauget
gamma-BHC (Lindane)	4.0	.08 as 24-hr average	.186 (10^{-5} risk)	.625 (10^{-5} risk)	.01 - .115
Endosulfan Sulfate		.056 as 24-hr average	.163 (10^{-5} risk)	.547 (10^{-5} risk)	.089 - 4.35
PCB's		.014 as 24-hr average	.00079 (10^{-5} risk)	.00079 (10^{-5} risk)	< .034 - 2.5
Heptachlor	0.1	.0038 as 24-hr average	.00278 (10^{-5} risk)	.00285 (10^{-5} risk)	.043 - .09
Aldrin	1.0	1/10 96-hr TLm for Bluegill = .46	.00074 (10^{-5} risk)	.00079 (10^{-5} risk)	.003 - .078

[1] Organisms

Sauget Treatment Plant Sites

(all values in mg/l)

Chemical	General Use Standards(a)	Public/Food Processing Standards(f)	1/10 96hr TLm (a)	Consumption of contaminated org.[1] & water (b)	Consumption of contaminated org.[1] (b)	Concentration rang found in ground-water at Sauget
Silver	.005					.001 - .036
Thallium			.013	.048	.18	.012 - .172
Total Phenols	0.1	.001				.053 - 6.7
Total Dissolved Solids	1000	500				584 - 1540
Chloride	500	250				24 - 330
Iron	1.0					23.6 - 23.9
Sulfate, as SO_4	500	250				330 - 360
Cadmium	0.05	0.01				3.94 - 7.65
Copper	0.02					.03 - .044
Selenium	1.0	0.01				.004 - .031

[1] Organisms

Sauget Treatment Plant Sites

FOOTNOTES

(a) **State of Illinois Rules and Regulations**
Title 35 Environmental Protection
Subtitle C Subpart B
Water Pollution
Purpose: The general use standards will protect the State's water for aquatic life, agricultural use, primary and secondary contact use and most industrial uses and ensure the aesthetic quality of the State's aquatic environment.

(b) EPA Ambient Water Quality Criteria (A Series).
U.S. Environmental Protection Agency
Cincinnati, Ohio: Environmental Criteria and Assessment Office, 1980 - 1985.

(c) Maximum Contaminant Levels proposed under the Safe Drinking Water Act (50 FR 46902, Wednesday, November 13, 1985).

(d) USEPA. 1985. U.S. Environmental Protection Agency
Office of Drinking Water Health Advisory
Office of Drinking Water, Washington, D.C.
Purpose: Health Advisories describe concentrations of contaminants in drinking water at which adverse effects would not be anticipated to occur. The Health Advisory numbers are developed from data describing non-carcinogenic end-points of toxicity.

(e) State of Illinois Rules and Regulations
Title 35 Environmental Protection
Subtitle F Subpart B
Public Water Supplies

(f) State of Illinois Rules and Regulations
Title 35 Environmental Protection
Subtitle C Subpart C
Water Pollution
Purpose: Subpart C contains the public and food processing water supply standards. These are cumulative with the general use standards of Subpart B and must be met in all waters designated in Part 303 at any point at which water is withdrawn for treatment and distribution as a potable supply or for food processing.

(g) Superfund Public Health Evaluation Manual.
U.S. Environmental Protection Agency, Washington, D.C.
Office of Emergency and Remedial Response, October 1986.

(h) Used Maximum Contaminant Level for 1,2-dichloroethane proposed under the Safe Drinking Water Act (50 FR 46902, Wednesday, November 13, 1985).

APPENDIX E

TOM HORNSHAW AND CONNIE SULLINGER ON THE SAUGET TREATMENT PLANT SITE

DATE: February 20, 1987

TO: Jeff Larson

FROM: Thomas C. Hornshaw, Connie A. Sullinger

SUBJECT: Comments on Sauget Treatment Plant RI/FS

After reviewing Geraghty and Miller's submission for the Sauget Treatment Plant site, we have the following comments on the report. Our comments will be limited to the chemical data presented in the report and to the implications of these data for the environment. (Our comments on this site should be considered in light of our previous comments on the Monsanto Krummrich site.)

Areas of concurrence: We concur with G & M's assessment that there are both on-site and off-site sources for the contamination present in the groundwater. The old pit and lagoons have probably been the source for some of the chemicals, while the Krummrich site (and probably others as well) may have been the source for other chemicals, such as the chlorinated nitrobenzenes.

We may or may not concur with G & M's assessment that "the waste is always above the water table" (p. 31), since this question does not appear to be adequately addressed in the study. For instance, the chemical analysis results for Soil Boring #BG-3 indicate major contamination at the deepest point sampled for chemical analysis, 7.5 ft. (Table 11), while HNu readings of 175 ppm were recorded at BG-3 at the maximum depth of the boring, 9 - 10.5 ft. (Table 10). The nearest monitoring well to this boring, GM-22A and B, also shows major contamination, and the depth to groundwater was about 16.2 ft. below the surface during the high stage of the Mississippi River on November 21, 1985 (Tables 3 and 4). Thus, it is conceivable that groundwater in this area may be moving up into the contaminated soil during high water periods on the Mississippi, since there was a difference of only 5.7 ft. between the bottom of BG-3 and the groundwater at high stage, and no samples were taken between 10.5 and 16.2 ft. below the surface.

We would like to point out that G & M indicates that groundwater movement fluctuates with the stage of the Mississippi, with the shallow aquifer travelling 3500 ft. eastward (p. 9) and the intermediate zone 4500 ft. eastward (p. 10) during high stage. This reinforces our opinion that the water table moves up and down as well as back and forth in the American Bottoms, depending on the stage of the Mississippi.

Finally, we concur with the statements in the recommendations that "Cleanup would require the pumpage of large quantities of water from the intermediate and perhaps the deep zones," (p. 26) and that pumping "would require approximately 80 years to accomplish this task." (p. 27).

Areas of disagreement: We do not agree that "remedial action with respect to groundwater contamination itself appears to be unnecessary" (p. 26). We feel that we would be derelict in our duties if we permitted 6980 ppb of benzene and 7340 ppb of vinyl chloride (known human carcinogens) to

remain in the water at well 22-A (Table D-1) without a very good reason. This well also contains very high levels of additional VOCs (including several other probable human carcinogens), chlorinated benzenes, phenol, nitrophenols, chlorinated phenols, total phenols, and ketones, and the concentrations of almost all these compounds have steadily increased over time (Tables D-1, D-2, and D-3). There are also very high levels of one or more of these contaminants or families of contaminants at wells 19-A, 21-B, 24-B, and DW-A. It seems to us, further, that this level of contamination in the groundwater, which is similar in nature to that of the Krummrich site but at slightly lower concentrations, has probably resulted in a considerable loading of organics to the Mississippi. (Recall that it was calculated that 77 lbs/day of organics were entering the Mississippi from the Krummrich site.)

We do not agree that capping the areas of greatest contamination (the old pit and lagoons) to prevent surface infiltration is the answer to containing the waste, since it is not certain to us that the shallow aquifer does not move up into the contaminated soil. Furthermore, we are not sure that containment is even an appropriate remedy for this site, since containment remedies have been known to fail over time. We feel, instead, that source removal, such as on-site or off-site incineration, may be the most appropriate remedy for this site, since there seems to be a fairly well-defined area of highly contaminated soil (i.e., the old pit and lagoons).

Finally, we do not agree with the reasoning by which G & M dismissed the incineration remediation option, such as difficulty of incineration, incineration emissions, incinerator failures, and workers' risks, since these factors are routinely addressed during the waste incineration (fixed or mobile) process.

TCH/CAS/psf

APPENDIX F

WILLIAM C. CHILD LETTER

TO MONSANTO

Illinois Environmental Protection Agency · 2200 Churchill Road, Sprin, . IL 62706

217/782-6761

Refer to: LI630200005 -- St. Clair County
Sauget/Sauget Sites
Superfund/General Correspondence

December 18, 1986

Warren Smull
General Superintendent of Environmental Affairs
Monsanto Chemical Company
500 Monsanto Avenue
Sauget, Illinois 62206-1198

Dear Mr. Smull:

The Illinois Environmental Protection Agency has completed its review of the Geraghty and Miller Ground Water Study for Monsanto in Sauget, Illinois.

The Geraghty and Miller Ground Water Study represented a reasonably good effort in determining the hydrogeological conditions occurring in the Sauget area.

The Agency feels that the study's conclusion for capping the Krummrich drum site is unacceptable. In addition the study's evaluated alternative does not meet the requirements of the Illinois Environmental Protection Act or CERCLA Reauthorization, which require permanent solutions and alternatives to land disposal.

In January 1987, IEPA will schedule a meeting with representatives of USEPA and Monsanto to discuss applicable remedial technologies.

The basic premise of the G & M report is that the pollutants released from Monsanto property become diluted and cause no significant impact to the environment. Evidence shows the contrary, fish from the Mississippi River have been found to contain the same chemical constituents in their flesh as that released from Monsanto properties.

IEPA feels that locating and eliminating the sources of these pollutants is the surest means of remedial action and is consistent with the intent of the recently amended Superfund Program. We would hope that Monsanto accepts IEPA'S opinion and seriously examines other remedial alternatives or combinations of alternatives in the pursuit of final remediation of the problem elements associated with the Krummrich Plant and Drum site.

Respectfully,

William C. Child

William C. Child, Manager
Division of Land Pollution Control

WCC:JL:bjh/1007g/9

cc: Bill Constantelos, USEPA
Bob Cowles
Jeff Larson
Glenn Savage
Ken Mensing
Monte Nienkerk
Rob Watson
Geordie Smith
Connie Sullinger
Tom Hornshaw

APPENDIX G

GEORDIE SMITH ON THE KRUMMRICH PLANT SITE

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY — MEMORANDUM

TO: Jeff Jasson, FSMU, RPMS — DATE: 12-5-86

FROM: Geordie Smith, Compliance S — ☑ Information only

SUBJECT: Comments on Geraghty & Miller Study — ☐ Response requested

I have reviewed the Geraghty & Miller (G+M) Study and I agree with some of their conclusions while I disagree with others. Basically, I agree with their conclusion that Monsanto plant operations have affected groundwater quality in the area, and I disagree with their proposals for remediation.

The G+M study identifies three primary sources of groundwater contamination: the Landfill Area, the Route 3 Drum Storage Area, and the Manufacturing Area itself. Of these, the major problem is the Landfill Area. Analyses of two of the monitoring wells in this area show over 1,000,000 µg/l Total Mean Concentrations of organics.

G+M's argument that contaminants loaded into the Mississippi River are diluted below detection limits is irrelevant. 77 lbs/day of organics loaded to the river is a serious environmental release. Even if contaminants are diluted below detection limits, this does not demonstrate nor guaranty absence of environmental impact. It may be true that there would be no direct human exposure to these contaminants, however, neither Monsanto nor our Agency could

make any definitive claim concerning lack of environmental impacts of continued release of contaminants, regardless of the ability to measure environmental concentrations.

I agree with S+M's conclusion that contamination from adjacent properties could be contributing to the overall problem. This is a confounding factor that hasn't been separated from their study results. Unfortunately, this argument is flawed if it is expected to lead to absolution of Monsanto's responsibility. Two wrongs don't make a right!! It is essentially identical to a criminal defense based upon the claim that a cohort also committed the crime.

In terms of the Route 3 Drum Storage Area, I generally disagree with S+M's conclusions and proposal. I agree with Monsanto's original proposal to excavate and incinerate. Excavation and removal of soil is a feasible, though admittedly not the cheapest, remediation method — but it's their own fault! Any sensible individual (even 40 years ago) should have realized that if you bury something in metal drums, eventually those drums will decompose and the contained material will be released. I interpret their action of burying the drums as deliberate postponed release to the environment,

and therefore I feel that they should have to bear the responsibility for, and the consequences of their actions. I don't think our state - the groundwater or the Mississippi River - should have to pay the price for their action.

Capping the drum site would minimize infiltration, but as the G+M study points out, water tables in the vicinity are effected by river stages, groundwater uses, etc..., to such an extent that directional flows are periodically reversed. Therefore, G+M's remediation proposal would not, as they claim, "virtually isolate the contaminants from the environment". It would merely redistribute environmental releases over a greater period of time.

I think the central issue here is that G+M's proposals will not eliminate releases to groundwater and subsequent dispersal into the environment. Groundwater is a state resource, not Monsanto's to contaminate or not as they deem economically reasonable.

I conclude by recommending implementation of a regulation and enforcement strategy that will encourage Monsanto to excavate, remove, and incinerate the soils they contaminated, or which will encourage them to deal with

their responsibility in some alternative, environmentally sound and acceptable manner.

Their proposal of no remediation for groundwater already contaminated doesn't sit well with me, but frankly, I don't know what should be done about it. At a minimum we should do whatever we can to prevent further insult. Perhaps installation of a hydraulic barrier to prevent offsite groundwater migration would be a viable compromise to groundwater cleanup vs no remediation. Alternatively, maybe they could capture contaminants in "cones of depression created by onsite pumping" to prevent offsite migration, filter below detection limits, and then properly handle the 77 lbs/day of organics now being loaded into the Mississippi. The G+M study concludes that such capture in cones of depression probably occurred prior to 1973 so they must consider this as feasible.

I also recommend checking with DWPC and/or PWS to see whether or not they might be concerned about 77 lbs/day organics loaded to the Mississippi River. Inter-divisional coordination may be warranted.

APPENDIX H

ROB WATSON ON THE

KRUMMRICH PLANT SITE

STATE OF ILLINOIS
ENVIRONMENTAL PROTECTION AGENCY

ADM
054-00

Subject MONSANTO
Data GROUNDWATER STUDY
Reviewed by ROB WATSON Date Dec 9, 1986

TO: JEFF CARSON

PER YOUR REQUEST, I HAVE THE FOLLOWING COMMENTS REGARDING THE GERAGHTY & MILLER STUDY.

1. WHY WERE THE G.M. MONITORING WELLS CLUSTERED (eg. G.M. 12, 39, 40, 41, 42, 44, 47) AND NOT SPREAD MORE EVANLY ACROSS THE MANUFACTURING FACILITY? not?

2. THE G.M. STUDY DID DISCUSS OR ADDRESS ANY OF THE SWMUs PREVIOUSLY IDENTIFIED BY MONSANTO. WHY NOT? DOES MONSANTO PLAN TO STUDY OR EXHUME ANY OF THESE POTENTIAL SOURCES OF CONTAMINATION?

3. WHAT IS THE SOURCE OF THE BLACK SILT, SAND, GRAVEL AND CINDERS IDENTIFIED ON MANY OF THE BORING DESCRIPTIONS (VOL III APPENDIX B)? WAS ANY OF THIS MATERIAL SAMPLED INDIVIDUALLY? IF SO WHAT ARE THE RESULTS?

4. VOL III PAGE B-4 DOES NOT FOLLOW A-3 COHERENTLY.

5. VOL III APPENDIX A STATES THAT BENTONITE SLURRY WAS USED TO SEAL THE ANNULUS DIRECTLY ABOVE THE SCREENED INTERVAL; HOWEVER, MANY OF THE WELL CONSTRUCTION LOGS IN APPENDIX C STATE THAT PELLETS WERE USED. HOW WERE THE PE S HYDRATED? FOR HOW LONG?

APPENDIX I

ROB WATSON ON THE SAUGET TREATMENT PLANT SITE

STATE OF ILLINOIS
ENVIRONMENTAL PROTECTION AGENCY

0357
ADM 39
054-002

Subject SAUGET GROUNDWATER STUDY

Data

Reviewed by ROB WATSON Date MARCH 12, 1987

TO: JEFF LATSON

PER YOUR REQUEST, I HAVE THE FOLLOWING COMMENTS ON THE DECEMBER 1986 GERAGHTY AND MILLER STUDY OF THE SAUGET TREATMENT PLANT SITES.

1. AS DISCUSSED IN THE IEPA MEETINGS ON THIS SUBJECT, I BELIEVE THAT, SIMPLY CAPPING AND MONITORING THE "HOT SPOTS" OR IDENTIFIED SOURCES OF CONTAMINATION IS NOT AN ACCEPTABLE REMEDY. AT A MINIMUM, THE HOT SPOTS SHOULD BE REMOVED AND HANDLED IN AN APPROPRIATE MANNER, POSSIBLY INCINERATION.

2. IN ORDER TO GET AN IDEA OF THE EXTENT OF THE CONTAMINATION IN THE AREA, ALL STUDIES SHOULD BE CONCLUDED AND IEPA SHOULD HAVE A DEFINITIVE LIST OF AREAS TO BE REMEDIATED, PRIOR TO MONSANTO OR THE VILLAGE OF SAUGET TAKING ANY ACTIONS AT THE "HOT SPOTS" IDENTIFIED IN THE GERAGHTY & MILLER STUDIES.

3. FOR FACILITIES, LIKE MONSANTO, SEEKING A RCRA PERMIT, SIMPLY "CAPPING AND MONITORING" SOLID WASTE MANAGEMENT UNITS (SWMUS) MAY NOT BE ADEQUATE TO MEET THE 3004(u) AND 3008(h) PROVISIONS OF RCRA AS THEY RELATE TO CONTINUING RELEASES FROM THOSE SWMUS.

APPENDIX J

ANGELA TIN ON SAUGET TREATMENT PLANT AND KRUMMRICH PLANT SITES

I .s Environmental Protection Agency · 2200 Churchill Road, Springfield, IL 62706

MEMORANDUM

DATE: March 25, 1987

TO: Tim Kluge

FROM: Angela Tin

SUBJECT: Sauget/Monsanto Ground Water Survey

Sauget (SSDRA) Groundwater Study

The contaminated areas in the Sauget treatment plant area include the old lagoons and the pit located near the northeast corner of the lagoons. The report indicates virtually no downward movement of the organics, with a westward flow of groundwater toward the Mississippi River (except when the river floods.) The westward movement is relatively slow in the shallow layer (approximately 7 ft/year) and increases as it gets deeper. The past practice of pumping groundwater for industrial use has ceased since 1962.

In any case, the groundwater flow has been both westward toward the Mississippi and eastward toward the industries in the past.

Shallow zone contamination may be due to the wastes once stored in the pit, or due to an off-site source (possibly TWI???). There were no organics found in soil samples.

Intermediate zone contamination is possibly due to the Monsanto production facility itself or less likely from the drum area. The compounds found generally relate back to the drummed Monsanto chemicals. It was recommended that Sauget maintains a semi-annual monitoring requirement for the volatile and to a lesser degree the acid and base-neutral fractions.

The report further says that there is no impact on the river itself since the migration in the shallow zone is so slow and the Mississippi River is 3400 ft. downgradient that it would require 100 years for the organics to reach the river. It also says that there is no effect on drinking water supplies since there are no potable water supplies. The pit is above the groundwater table and has an impact only when the water rises at about 1.5% of the time. The only source of contamination from the pit area is from rainfall infiltration. A low permeability cap was suggested as the solution.

Rte 3 Drumsite of the Monsanto Plant

The abandoned drums containing nitrochlorobenzene were excavated and removed for incineration. The drums which were corroded and mixed with the soil showed contamination at the shallow zone and that downward migration to the groundwater or westward movement to the River would be minimal according to the same reasons given above. Corrective action includes capping the area.

Mansanto Landfill Area

The report states that movement of any organics from Monsanto would probably be westward but even this movement was unlikely and the source of contamination would be from the landfill itself due to the same reasons above. Another possible source may be from other industries, leaky sewers, leaky underground tanks, spills, etc. It also says that 77 lbs/day of organics were found at the river's edge at the landfill but these were reduced drastically due to dilution with the river. There are no remedial actions proposed.

Recommendations

There are no impacts to the Water Division, except to include groundwater monitoring in the Sauget permit, to permit the individual industries through state permits, and to require an effective pretreatment program through the Village. However, even though there are numerous extraneous circumstances such as undefined plumes, bi-directional groundwater flows, old sewers, infiltration problems, the proximity of other facilities, etc. Monsanto (and TWI to an extent) seem to be contributing greatly to the entire situation. The report is biased towards Monsanto, and while there does not appear to be any immediate affects on the Mississippi, the presence and levels of these organics should be of concern.

AT:st:1955g,57-58

cc: Jeff Larson, DLPC
PT File